International standard IEC TS 60034-30-2 for variable speed motors

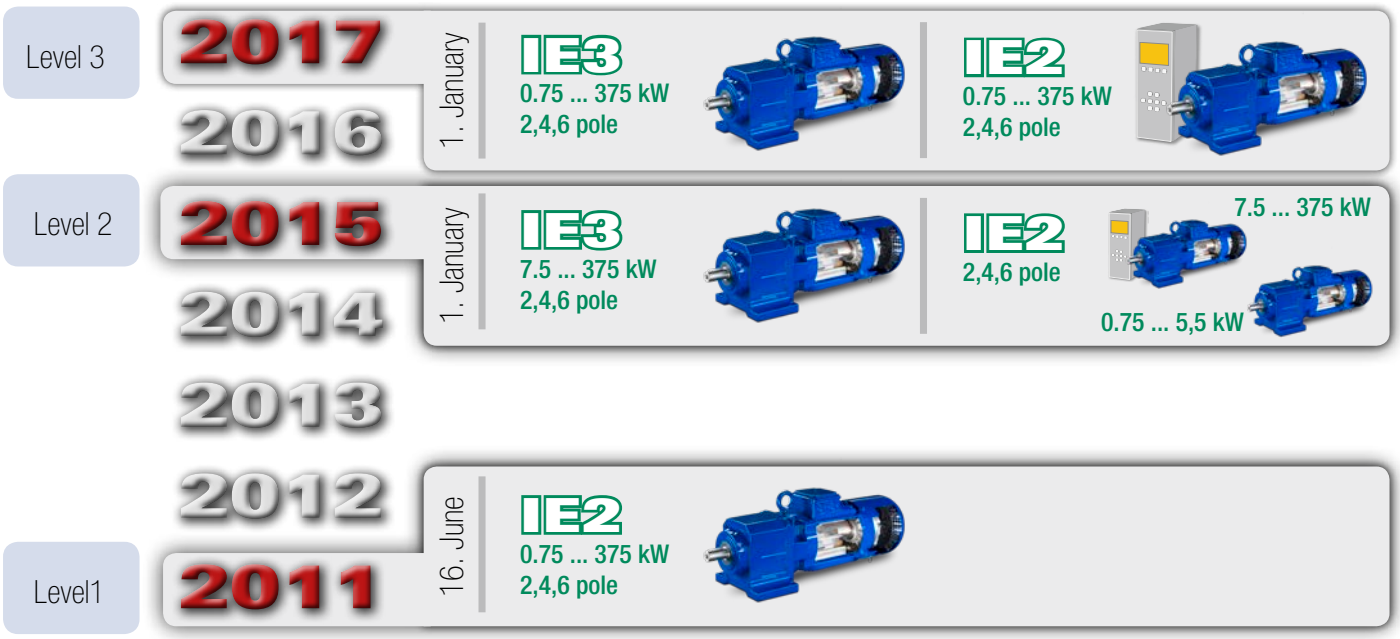
Bauer Gear Motor®
Altra Industrial Motion

New international standards for electric motors

In the industrial sector, electric motors account for about 70% of electricity consumption and are thus the most significant consumers of electrical energy. Reducing the energy requirements of these drive systems by increasing their efficiency contributes to an equivalent reduction in CO_2 emissions.

In the European Community, EU Directive 2005/32/EC and the follow-on directive 2009/125/EC established the first requirements for environmentally responsible design of energy-using products. These requirements were implemented for electric motors in Regulation (EC) 640/2009. As an additional requirement for the European market, since 1 January 2017 all motors with rated power from 0.75 kW to 375 kW must conform to energy efficiency class IE3, or alternatively IE2 for use in inverter operation. The international standard IEC 60034-30-1 defines efficiency classes from IE1 to IE4 for line-operated electric motors. These efficiency classes are specified for AC motors operating at rated speed and rated torque. In some cases, efficiency-optimized asynchronous motors developed to comply with the Standard Efficiency (IE1) to Super Premium Efficiency (IE4) classes are longer or larger than before.

Statutory milestones for minimum efficiency requirements in Europe



In the current statutory framework for the marketing of electric motors, it should first be noted that all regulations worldwide currently only apply to asynchronous motors designed for operation directly from the AC line (line-operated motors). Motors supplied with special windings (including asynchronous motors) and permanent magnet motors are therefore not included and can be sold without having to comply with current motor regulations, as long as they cannot be operated directly from the AC line. As previously mentioned, all minimum efficiency values only apply to the rated operating point of an electric motor, which in Europe means 50 Hz and rated torque. There are presently no regulations anywhere in the world that encompass the partial-load range.

Effective 1 June 2016, it is also stipulated in the USA that geared motors with line-operated asynchronous motors (from 0.75 kW / 1 HP to 373 kW / 500 HP) must conform to energy efficiency class IE3. As in Europe, exceptions are possible, for example special motors designed for intermittent duty. For China it is presently necessary to supply IE2 motors.

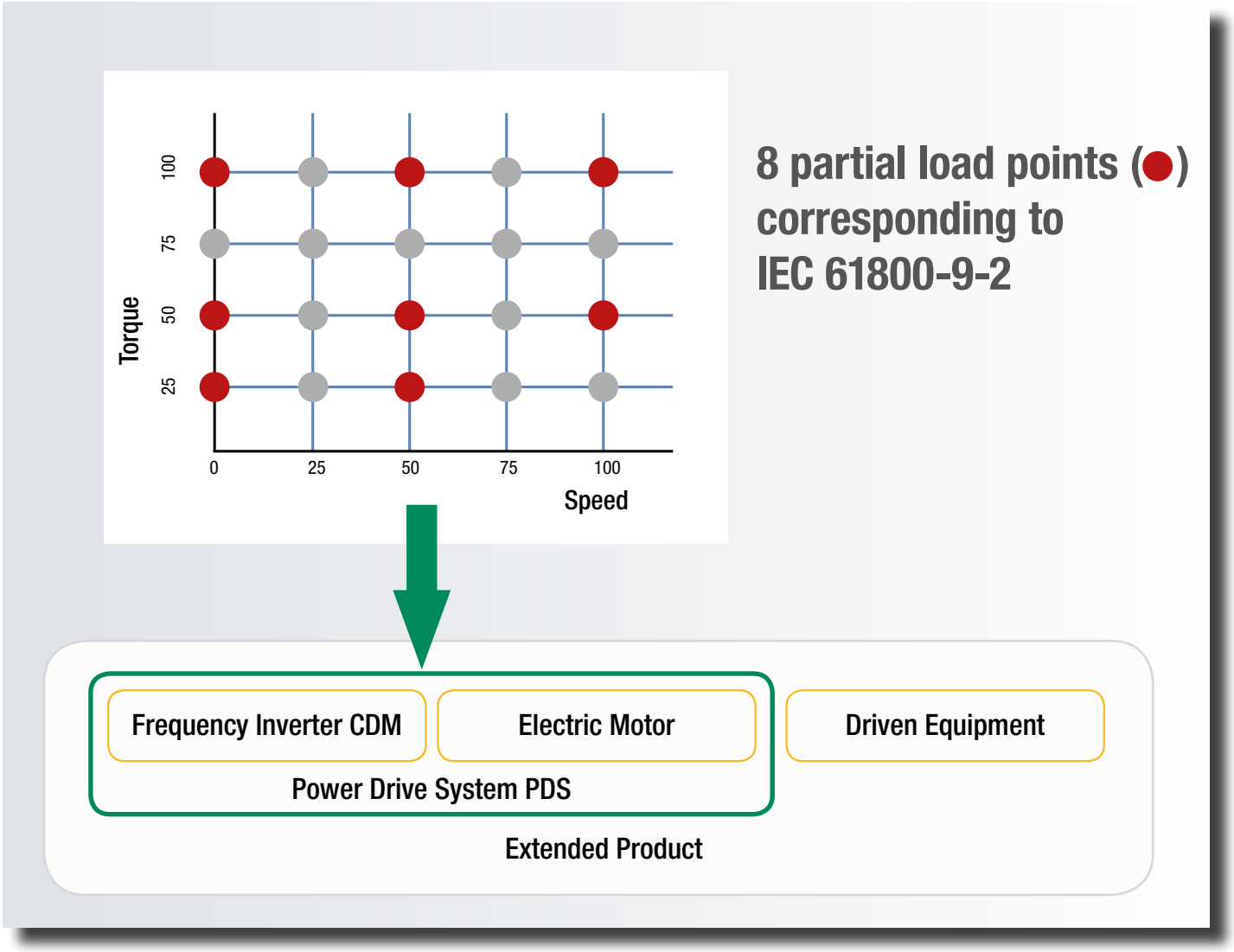
Status of motor standards

In the first place, the motor standards should be regarded independently of statutory provisions, which often use the definitions of applicable national and international standards but do not necessarily coincide with them. Our customers often expect, and sometimes even specify, compliance with European standards (EN) or international standards (IEC). There are presently the following important new standards which are applicable:

Ecodesign standard EN 50598-2 and the follow-up standard IEC 61800-9-2

This standard specifies the procedure for determining the losses of the complete drive system (PDS), which for example means the motor and frequency inverter (variable speed drive). The key new aspect of this standard is that it also applies to other motor types, such as permanent magnet motors. It also defines eight load points for both the motor and the frequency inverter.

This allows the system power losses to be calculated by summation in the partial load range, which means they can also be determined for realistic application conditions. This standard applies to the power range from 0.12 kW to 1,000 kW. It has also been adopted as an international standard with the designation **IEC 61800-9-2**, effective since the start of 2017.



New standard IEC TS 60034-30-2 for variable speed motors

The new standard IEC TS 60034-30-2 was released on the 8th December 2016 and will remain unchanged until 2019. It applies to all motors in the power range from 0.12 kW to 1,000 kW which cannot be operated directly from the AC line. Only servo motors for dynamic motor control applications are excluded. The efficiency is specified for a load point at 90% rated speed and 100% rated torque. The additional losses due to the inverter (harmonics) are also taken into account in the determination of the efficiency. Efficiency classes IE1 to IE5 are defined. Only the efficiency class may be stated on the motor nameplate; the efficiency percentage is not stated. The manufacturer must therefore specify the power loss at seven load points in accordance with IEC 61800-9-2. This enables users to determine the power loss of their overall system (inverter and motor) under realistic load conditions.

The 7 load points for specifying power loss

[%]	Speed n	Torque M	Power P
P1	90	100	90
P2	50	100	50
P3	25	100	25
P4	90	50	45
P5	50	50	25
P6	50	25	12.5
P7	25	25	6.25

New optimized asynchronous motors for frequency inverter operation

It is usually necessary to use motors with at least IE3 efficiency for applications which predominantly require line-operated asynchronous motors (without an inverter) and continuous duty operation (S1). Exceptions are only possible in specific situations, for example other duty cycles (e.g. S3, intermittent operation) or where an inverter can additionally be employed.

In drive applications where frequency inverters are predominantly used to control motors, it is possible to use an asynchronous motor with a corner frequency of 70 Hz at 400 V. This motor is optimized for inverter operation, which means it can also be used in compliance with the new IEC TS 60034-30-2 standard. As this motor cannot be operated directly from the AC line, this drive is not subject to the statutory regulations for line-operated motors and can therefore be deployed worldwide.

In accordance with the new IEC 60034-30-2 standard, Bauer Gear Motor has developed a new series of asynchronous motors compliant with efficiency class IE4.

Thanks to better motor utilization (70 Hz corner frequency), costs are lower than with comparable IE3 or IE4 line-operated motors, and in many cases these optimized motors are significantly more compact.

Scope and design points of IEC TS 60034-30-2

For efficiency classification, the rated point of the motor is equivalent to the rated point of the frequency inverter according IEC 61800-9-2 and is located at the junction of 90% rated speed (n_{90}) and 100% rated torque (M_N). Testing at 90% speed allows for the voltage drop of the electronic components of the frequency inverter, so that the motor operates with constant magnetic flux.

Motors inside the scope of IEC TS 60034-30-2

- Variable speed electric motors outside the scope of IEC 60034-30-1
- Also other motor technologies, such as PMSM
- Motors designed for operation with a sinusoidal supply voltage but not suitable for line operation
- PMSM, synchronous reluctance, DC synchronous and induction motors which are designed exclusively for inverter operation
- Rated output power between 0.12 kW and 1,000 kW
- Rated voltage from 50 V to 1,000 V
- Rated speed from 600 rpm to 6,000 rpm
- Ambient temperature range -20°C to +60°C

Motors outside the scope of IEC TS 60034-30-2

- Motors with mechanical commutators (e.g. DC motors)
- Motors designed to be operated fully immersed in a liquid
- Motors fully integrated into a product (e.g. a gear, a pump, a fan or a compressor), whose energy efficiency cannot be measured independently of the product concerned
- Brake motors where the brake is an integral part of the motor structure and does not have its own power source for efficiency determination and cannot be dismounted
- Motors with soft-start by means of a frequency inverter followed by direct line operation (IEC 60034-30-1)
- Motors designed for servo applications

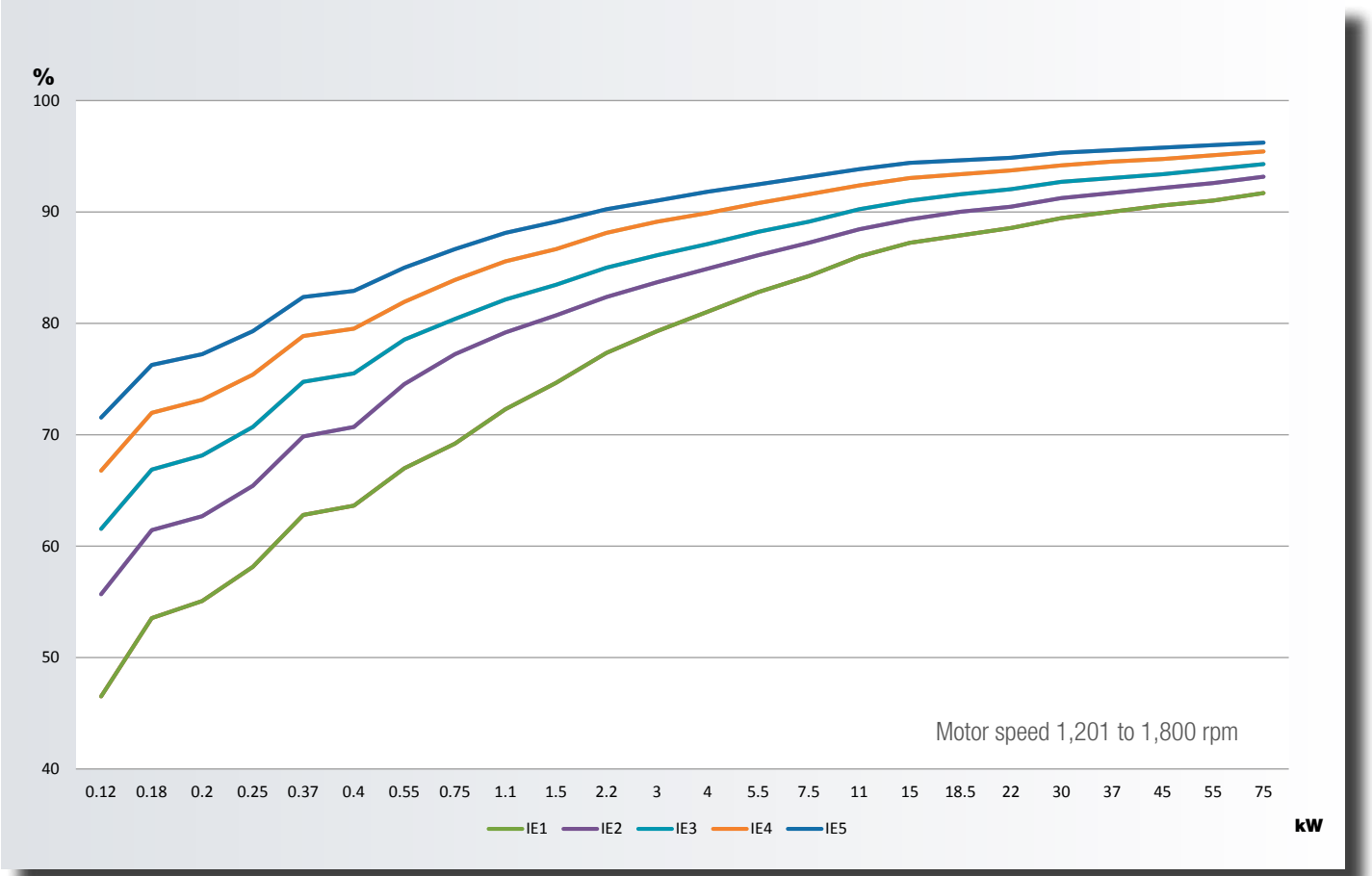
Efficiency classes from IE1 to IE5

The nominal efficiency η_n of the individual IE classes can be calculated from the respective reference values stated in IEC 60034-30-1. The resulting value is reduced by the harmonic loss r_{HL} in the various speed ranges.

$$\eta_n = \frac{1}{1+(1+r_{HL})\cdot\left(\frac{1}{\eta_{ref}}-1\right)}$$

r_{HL} = 0.15 (15%) for motors with rated power up to and including 90 kW
r_{HL} = 0.25 (25%) for motors with rated power above 90 kW

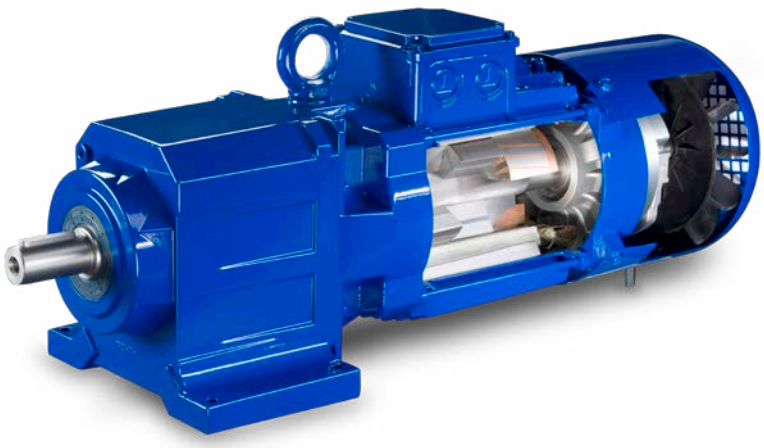
Efficiency classes according to IEC TS 60034-30-2



Excerpt from the standard

Examples: Motor designs – optimized asynchronous motors for frequency inverter operation at 70 Hz

P_N [kW]	Type	IEC TS 60034-30-2 *IE4-limit*
0,75	D..09SA4	81,48
1,1	D..09LA4	83,35
1,5	D..09XA4	84,78
2,2	D..09XA4.	86,44
3	D..11MA4	87,67
4	D..11LA4	88,67
5,5	D..13MA4	89,68
7,5	D..13LA4	90,57



Scope of IEC 60034-30-1/2

	Motors which **can** be operated **directly** from AC line voltage		Motors which **cannot** be operated **directly** from AC line voltage	
IEC Standard	**60034-30-1**		**60034-30-2**	**Not applicable**
Supply voltage	Direct from AC line	Provided by inverter	Require inverter	Servo Drives
Motor	Standard Asynchronous Motors		Motors with special windings and PMSM	Servo Motors
Eff. Label	IE1, 2, 3, 4		IE1, 2, 3, 4, 5	none
Market share	60 %	30 %	< 1 %	10 %
	Established technology		Emergent technology	Established technology

The new IEC TS 60034-30-2 standard fosters new motor technologies

The Bauer Gear Motor motor portfolio

IE-Class \ kW	0.12	0.18	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5	9.5	11	15	18.5	22	30	37	45
IE1 Asynchronous	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IE2 Asynchronous	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IE3 Asynchronous	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IE4 Asynchronous					●	●	●	●	●	●	●	○	○	○	○	○	○	○			
IE3 PMSM								●	●	●	●	●	●	●	●	●					
IE4 PMSM		○	○	○	●	●	●	●	●	●	●	●	●	●	●						
IE5 PMSM							●	●	●	●	●	●									

● = planned

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